

## SECTION III.—FORECASTS.

## STORMS AND WARNINGS FOR JANUARY, 1915.

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## WIND STORMS.

On the morning of January 1 a northwestern disturbance was centered over western Lake Superior attended by snows, and advisory warnings of fresh to strong west to northwest winds were sent to open ports on Lake Michigan, and during the day and night the winds occurred as forecast. On the morning of the 2d, as pressure was falling off the North Pacific coast, southeast storm warnings were ordered at stations on the Straits of Juan de Fuca, and at noon of the same day they were extended to all stations on the North Pacific coast. As the disturbance persisted on the 3d over western Oregon, the warnings at Marshfield, Oreg., were changed to southwest, and southeast warnings were ordered on the California coast from Eureka to Point Reyes. Another disturbance appeared off the North Pacific coast during the night of the 4th and 5th, and at 10:30 a. m. of the 5th southeast warnings were ordered on the California coast from Eureka to Point Reyes, and during the early evening extended northward along the entire north coast. High winds occurred as forecast, but the storm was not of long duration and warnings on the Washington-Oregon coast were lowered early on the morning of the 6th.

A disturbance from the Canadian extreme northwest reached western Lake Superior by the morning of the 6th, and at the same time an offshoot from this disturbance that had moved southward along the eastern slope of the Rocky Mountains had reached Missouri. By the evening of the 6th there was a single storm center over lower Michigan with pronounced development and advisory messages for strong west to northwest winds were sent to lake ports. At the same time southwest storm warnings were ordered along the Atlantic coast from Wilmington, N. C., to Bangor, Me. The storm moved northeastward with increasing intensity and winds on Lake Michigan and the Atlantic coast occurred as forecast, New York City reporting a velocity of 64 miles an hour from the southeast during the night of the 6th-7th. On the morning of the 7th warnings were extended on the Maine coast east of Bangor, and at the same time they were ordered down from Wilmington to Fort Monroe. By this time another disturbance had appeared off the north Pacific coast and early in the evening southeast and southwest warnings were displayed from Point Reyes northward, but only at stations along the immediate coast. Only moderately strong winds attended this storm.

During the next three days there were no disturbances of consequence. A moderate depression that first appeared over southeast Colorado on the morning of the 9th moved southeastward to Oklahoma during the ensuing 24 hours, and small craft warnings were ordered on the Gulf coast from Pensacola to Carrabelle, Fla. At this time the fourth north Pacific disturbance of the

month was approaching the coast, and during the day and evening southeast warnings were ordered at all stations on the north coast. Fresh southerly gales attended this storm and during the 11th they extended southward to the north California coast, warnings having been previously ordered as far south as San Francisco. By the morning of the 11th the Oklahoma disturbance had reached the mouth of the Mississippi River and, because of a strong high area over the north Atlantic States, northeast storm warnings were ordered at 10:30 a. m. from Tybee Island, Ga., to Fort Monroe. At 2:30 p. m. southeast warnings were also ordered at Jacksonville and on the Gulf coast from Cedar Keys to Punta Rasa, Fla. As the disturbance had now turned toward the northeastward, northeast warnings were ordered during the night of the 11th as far north as New York City, and on the morning of the 12th at all stations north of New York. By this time the storm was central over extreme southern New Jersey with a barometer reading of 28.90 inches and the high winds resulting covered the entire Atlantic and east Gulf coasts with a maximum velocity of 76 miles an hour from the northeast at Nantucket, Mass., during the night of the 12th-13th. As the high winds continued some time after the passage of the storm center the warnings on the south coast were changed to southwest on the morning of the 12th, on the middle coast during the night of the 12th, and on the morning of the 13th on the New England coast. The latter warnings were, however, ordered down at 9 p. m. of the 13th by which time the storm had passed off the New England coast.

Steadily falling pressure on the north Pacific coast during the 12th indicated the approach of another storm, and at 6 p. m. southeast warnings were ordered on the California coast from San Francisco to Eureka, and at 6:15 p. m. southeast and southwest warnings were ordered for Marshfield, Oreg., the mouth of the Columbia River, and the Straits of Juan de Fuca. On the morning of the 13th the storm was more definitely developed and warnings were ordered for the balance of the north Pacific coast. Southeast to south gales attended this storm with a maximum velocity of 60 miles an hour from the southeast at North Head, Wash.

On the evening of the 14th pressure was low throughout the West with three or four separate centers of disturbance. By the evening of the 15th there was a principal disturbance of marked character over north central Texas and a secondary over southeast Colorado. As pressure had been falling rapidly over the Southwestern States during the 15th, southeast storm warnings were ordered at 4 p. m. from Brownsville to Galveston, Tex., and at 10:30 p. m. were extended eastward to Apalachicola, Fla. The disturbance turned to the northeastward after reaching north central Texas, leaving a secondary near the mouth of the Rio Grande and strong southeast to south winds occurred on the Gulf coast. The principal disturbance continued north-northeastward and at 8 p. m. of the 16th was central over northern Iowa, with a barometer reading of 29.34 inches. Twelve hours earlier advisory notices of east to north gales had been sent to open ports on Lake Michigan and they were repeated at 10 p. m. with notices

of change in direction to west and northwest. At the same time, owing to the marked pressure gradient, southwest storm warnings were ordered on the Atlantic coast from New York City to Norfolk, Va. The resulting winds, however, during the next 24 hours were only fresh. The secondary disturbance that was near the mouth of the Rio Grande on the morning of the 16th now moved northeastward with increasing intensity and by the night of the 17th had reached extreme southern Mississippi. Southeast storm warnings were now ordered on the Atlantic coast from Jacksonville to Morehead City, N. C., and northeast warnings farther northward to Fort Monroe, Va. By the morning of the 18th the disturbance extended in trough shape from the east Gulf States to Virginia and southeast warnings were ordered from Baltimore to Boston. At 8 p. m. of the 18th the disturbance had become more localized and was central over southwestern Virginia with increased intensity; the warnings from Hatteras, N. C., to Fort Monroe were now changed to northwest, and southwest warnings were ordered north of Boston. Strong winds occurred during the passage of this storm, but no severe gales, New York City reporting a velocity of 52 miles from the south during the 18th (the highest velocity reported for this storm).

From the 18th to the 20th, inclusive, a disturbance of quite marked character moved southeastward from Saskatchewan to the middle Mississippi Valley and thence passed eastward off the Atlantic coast. This disturbance was quite well-defined so far as barometer readings were concerned, but owing to the prevailing low pressure on all sides no high winds occurred and no storm warnings were ordered.

During the 20th a disturbance developed along the eastern slope of the central Rocky Mountains and by the evening of the 21st it covered west Texas, with a strong and cold high area to the northward. Advisory warnings for increasing north and northeast winds were at once issued for open ports on Lake Michigan, but the winds that followed were only moderate, although accompanied by snow in substantial quantity. The Texas disturbance reached western Arkansas by the morning of the 22d, and small craft warnings were ordered from Pensacola to Carrabelle, Fla. As pressure over the west Gulf States continued to fall, southeast storm warnings were ordered at 1:10 p. m. for the New Orleans section and at 2:45 p. m. from Mobile, Ala., to Carrabelle, Fla., with instructions to change to northwest at sunset. At 3 p. m. northwest warnings were also ordered for the Louisiana and Texas coasts. By the night of the 22d the disturbance had reached Indiana and at 10:30 p. m. southeast warnings were ordered from New York northward, except on the Maine coast, where northeast warnings were ordered displayed. Strong northerly winds occurred during the night of the 22-23d on the west Gulf coast and strong southerly winds on the north Atlantic coast during the 23d. On the morning of the 23d a secondary disturbance from the mouth of the Rio Grande had reached the middle Gulf coast and the warnings in that section were therefore changed to northwest at 11 a. m. On the morning of the 24th this Gulf disturbance was central over southwest Georgia with a strong high area to the northward indicating the probability of strong northeast winds on the coast, and at 10 a. m. northeast warnings were ordered from Charleston to Boston. At 10:30 p. m. the warnings were extended to all stations north of Boston, and strong shifting winds and gales prevailed quite generally over the districts where warnings had been ordered. On the morning of the 25th the storm was central over southern

New Jersey. Warnings were still displayed north of Boston and they were ordered continued from New London, Conn., to Boston. The storm passed to the northeastward of Maine during the night of the 25th.

After a respite of 11 days a disturbance appeared off the California coast on the morning of the 24th and southeast storm warnings were ordered from Eureka to Point Reyes. The disturbance was not of severe character and no high winds were reported. On the evening of the 26th there were indications of the approach of another disturbance toward the north California coast and on the morning of the 27th southeast warnings were again ordered from Eureka to Point Reyes. This storm increased considerably in intensity during the next 12 hours and at 6:40 p. m. southeast warnings were extended northward to Marshfield, Oreg. As pressure was still falling on the morning of the 28th the warnings were continued from Eureka to Point Reyes and a few hours later were extended southward to San Francisco and continued northward to Marshfield. By the morning of the 29th pressure was very low on the Pacific coast with a barometer reading of 29.14 inches at Eureka, Cal., and southeast warnings were therefore hoisted at all other points on the Pacific coast. High winds occurred along the entire coast during the 28th and 29th and on the 30th the disturbance decreased considerably in intensity.

On the morning of the 28th pressure was falling in the Atlantic States and continued to fall rapidly during the day over new England. There were some indications of strong northeasterly winds and northeast storm warnings were ordered at 4:30 p. m. from Block Island to Eastport. By evening, however, the threatening conditions had disappeared and the warnings were lowered at 9 p. m. The next disturbance noted appeared on the morning of the 30th over southeast Idaho and the adjacent States, probably an offshoot from the extensive Pacific coast storm.

It appeared to be developing eastward and southeastward and small craft warnings were ordered on the Gulf coast from Brownsville, Tex., to Carrabelle, Fla., for the strong winds that occurred during the 30th. By the evening of the 30th the storm was central over the southwestern States with somewhat increased intensity and advisory warnings of strong easterly winds with snow were sent to open ports on Lake Michigan. By the morning of the 31st the storm was over Oklahoma with strong high pressure to the northeastward and southeast warnings were ordered from Galveston to Carrabelle, Fla. During the afternoon they were extended on the Gulf coast as far as Tampa and also ordered on the Atlantic coast from Jacksonville to New York. Strong winds and gales prevailed on the Gulf coast, but on the Atlantic coast the winds were only moderately strong owing to the slow movement of the storm which by the night of the 31st had moved only to Missouri, thereby necessitating additional advices to open ports on Lake Michigan of strong northeast to north winds with snow.

As pressure was again falling on the north Pacific coast on the morning of the 31st southeast storm warnings were ordered from San Francisco to Eureka and early in the evening extended northward as far as the Straits of Juan de Fuca.

#### COLD WAVE AND FROST WARNINGS.

On the morning of the 2d a disturbance was central over Ontario attended by quite high temperatures and cold wave warnings were therefore ordered for the southern upper Lake and western lower Lake region and the

upper Ohio Valley. A moderate cold wave occurred over the districts indicated on the following day. As the high pressure following this Ontario disturbance extended southward to the Gulf, frost warnings were also ordered on the morning of the 2d for Alabama, Mississippi, Georgia, and interior Florida, but owing to the prevalence of cloudy weather the warnings were not generally successful. By the evening of the 2d the Ontario disturbance had passed off the New England coast and cold-wave warnings were therefore ordered for New York and the greater portion of New England. These warnings also failed of verification, except in a few places, on account of the slow rate of fall, although the temperatures were sufficiently low.

Following the eastward movement of the Rocky Mountain disturbance on the 5th and 6th frost warnings were ordered for interior Louisiana and southeast Texas and warnings of freezing temperature for northeast Texas. These warnings were fully justified by the occurrence of frost on the morning of the 7th as forecast. Similar forecasts for the 8th, however, failed of verification owing to cloudy weather caused by a moderate disturbance near the mouth of the Rio Grande. Following the Pacific coast storm of the 6th to the 8th there was a rapid rise in pressure and on the morning of the 9th warnings were issued for severe frost in California. Heavy frost occurred on the morning of the 10th in portions of northern California.

A disturbance that was over Oklahoma on the morning of the 10th was followed by a strong and moderately cold high-pressure area and frost warnings were therefore ordered for the west Gulf States with excellent verification. On the morning of the 12th frost warnings were extended to the East Gulf States, including northern Florida, and again on the 13th in Georgia and north Florida. In both instances frost occurred as forecast. On the morning of the 12th warnings of heavy frost were issued for northern California, but the persistence of the storm conditions caused a failure of the forecast. On the morning of the 15th and 16th conditions were more stable and warnings of heavy frost for California were followed by quite general verification, except over the extreme southern portions. On the morning of the 6th the rapid north-northeastward movement of the storm that was then over western Missouri, combined with the high area to the northwestward, indicated the approach of colder weather and cold-wave warnings were therefore issued for the lower Missouri and upper Mississippi Valleys. The further inclination of the storm back toward the northward disturbed the existing conditions and the subsequent fall in temperature was not sufficient to justify the warning, although the 24-hour fall in temperature amounted to as much as 40° in portions of east Kansas and west Missouri. Cold-wave warnings were also ordered on the morning of the 16th for interior east Texas, northern Louisiana, Arkansas, and extreme eastern Oklahoma. These also failed of verification, although the fall in temperature ranged from 16° to 28° and the line of freezing temperature extended well into central Texas. On the morning of the 7th the passing of a secondary disturbance over the middle Gulf coast indicated the necessity of further east and cold-wave warnings in the South and they were therefore ordered generally throughout the Gulf States, except eastern and southern Florida. Cold-wave warnings were also ordered at the same time for central Tennessee, southern Kentucky and the central and eastern

portions of lower Michigan. The warnings in the South failed utterly, except in Texas, owing to the northward development of the disturbance. Cold-wave warnings for the States to the northward also failed, although there was a considerable fall in temperature accompanied by snow.

Frost warnings were also issued for California on the morning of the 17th and again on the 18th, 19th and 23d, those of the latter date failing of verification on account of rain. On the morning of the 19th frost warnings were issued for Louisiana and southeast Texas, but failed of general verification on account of falling pressure to the northward; warnings were repeated on the 20th for Louisiana, but for a similar reason no frosts were reported. By the night of the 21st, however, the disturbance over Texas and the cold high area to the northward indicated an early and decided change in temperature conditions. Cold-wave warnings were ordered for the entire state of Texas, except the extreme south and extreme west portions; also for northwest Louisiana, Oklahoma, Arkansas, north and west Mississippi, eastern Kansas, eastern and southern Missouri and extreme southern Illinois. These warnings were repeated on the morning of the 22d and during the evening of the 22d were extended so as to cover entire Ohio Valley. The cold wave that followed was quite extensive although not very severe, except in portions of the Dakotas and Nebraska, and on the morning of the 23d it covered the Plains States and the Great Central Valleys, except the upper Ohio.

During the 23d cold wave and freezing temperature warnings were continued for the west Gulf States, and on the evening of the 23d cold-wave warnings were ordered for the Atlantic States, except Florida, as it appeared at that time that the southern disturbance would pass off the Florida coast. Instead, however, it drifted slowly northward so that the cold weather did not extend farther south than South Carolina nor did it reach the north Atlantic coast, although, of course, temperatures fell decidedly. Cold-wave warnings were also ordered on the morning of the 24th for western South Dakota and eastern Wyoming, as pressure was then low over Wyoming with a reinforced cold high area coming down from the north. This warning was very timely as the temperature at Sheridan, Wyo., on the morning of the 25th was -20°. On the evening of the 24th cold-wave warnings were extended to east Colorado, Kansas, and the lower Missouri Valley, but without verification, except over a very limited area. On the morning of the 25th warnings of frost and freezing temperature were again sent to Texas and Louisiana, but cloudy weather with low pressure to the northward caused the temperature to rise. On the evening of the 26th a very cold high-pressure area was central over the Canadian Northwest. Low temperature had prevailed for several days over the northwestern States and no further warning was necessary, but warnings were ordered for east Colorado, western and southern Wyoming, eastern and southern Iowa and the interior of northern Illinois, and during the 27th they were extended generally over the Lake region, the Central Valleys, New England and the Middle Atlantic States. This cold wave proved to be the most pronounced and extensive one of the present winter and temperatures as low as zero occurred almost to the Ohio River. By the morning of the 29th the cold wave had passed, except in New England, and no more cold weather occurred by the end of the month.